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rWeather is Our Real-time View on Our Roads and Weather

Although many agencies and businesses collect and distribute weather information, no one has yet targeted that information specifically for travelers-until now. The Washington State Department of Transportation (WSDOT) has begun a program to collect and disseminate real-time and predictive statewide road and weather information. It is called rWeather (road-Weather/"Our" weather). The program will gather data from a variety of sources and will provide statewide weather and road-condition reports and forecasts via a comprehensive Web site. This detailed information will help the state better manage and maintain the roadways. The traveling public will also benefit from knowing current and future weather and driving conditions.

The program is being accomplished in two phases. In the first phase, WSDOT is concentrating on gathering all available data and on developing better ways to more accurately predict detailed weather conditions. These high resolution weather forecasts will then be integrated with information from road condition models developed for use in Washington State.

Phase II of the program is dedicated to data dissemination. The developed weather and road information is being mapped so that it can be presented on a dedicated Web site and via other media.

The project is paid for by a \$1.25 million grant from the U.S. Department of Transportation and \$312,500 from WSDOT. Bill W. Brown, Transportation Engineer with WSDOT's Advanced Technology Branch, is the rWeather project manager.

Weather Data Collection

The first task of the program is to create a highly dense database of Washington State weather observations.

Over the past ten years the Northwest Regional Modeling Consortium, a group of

local, state, and federal agencies, has established meteorological observing networks that collect data in real time. Sources across the state include agricultural monitoring networks, air pollution sensing stations, and even television station weather networks, as well as the resources of the National Weather Service (NWS) Advanced Surface Observation Sites and Federal Aviation Administration. WSDOT has joined this consortium, adding data from its own road/weather information stations (RWIS) so that all members now have access to data from nearly 400 remote weather sites

The number of observation stations will continue to grow. For example, WSDOT plans to add 12 automated RWIS sites to its current 28 in strategic areas where current data are lacking. In addition, the program will place automated data stations on the Tacoma Narrows Bridge and six state ferries traveling Puget Sound, which is currently a critical gap for weather models.

By combining all available networks statewide, integrating other sources of weather information (radar, satellite, aircraft observations), and judiciously adding sites to fill in data gaps, the program will create a very detailed description of current Washington State weather conditions.

Weather Prediction

A second aspect of the effort will be the use of a high-resolution weather prediction system to generate detailed weather forecasts throughout the state. That system, coupled with the dense array of observations, will supply WSDOT and other government agencies, the public, and businesses with information on existing and forecast weather conditions that could affect transportation. Clifford F. Mass, professor of Atmospheric Sciences, is leading this portion of the project at the University of Washington.

Over the past five years, the Northwest Regional Modeling Consortium has supported the University of Washington's efforts to develop high-resolution, numerical weather prediction over the Pacific Northwest. By combining resources, the consortium has purchased a powerful 14-processor computer and has adapted the state-of-the-art Pennsylvania State/NCAR forecast model (the MM5) to run twice daily, producing 48-hour forecasts for the Pacific Northwest. The rWeather program has already upgraded the weather forecasting computer so that 4-km forecasts are available for the entire state-the highest resolution numerical weather prediction in the U.S. With the addition of a second 14-processor computer from the Environmental Protection Agency, the consortium will also begin modeling statewide Oregon weather, which will help in better predicting southern Washington conditions.

Researchers also plan to interpolate forecasts of weather parameters such as temperature

and precipitation with roadways and ferry routes within Washington State.

According to Mass, the UW and WSDOT are in a good position to accomplish these tasks. Mass said, “There are other projects across the country that are trying to do some of this, but in many ways we are technologically far ahead of the rest of the country. One of the reasons that we have such a lead is that we’re already very well advanced in collecting the data and also in experimenting with high-resolution computer forecast models. The Northwest Regional Modeling Consortium has worked together to create the infrastructure of very powerful computers, and we have access to many of the data that are being collected around the state in real time. The support we’re getting for this project is enabling us to push the technology of local weather prediction much faster than we’d be able to do otherwise and farther than it’s been pushed anywhere.”

Roadway Condition Prediction

Researchers will also develop road condition prediction models for use with observed and forecast atmospheric data. To make operational decisions about crew and equipment deployment, operations personnel need forecast and real-time data describing whether a section of roadway will experience conditions such as frost or ice. The program will acquire, evaluate, and test a road surface model developed at the University of Washington. The pavement prediction models will first be integrated with the MM5 land surface model for testing and evaluation. Later, the model’s use will be expanded to integrate real-time and forecast atmospheric data collected by the Northwest Modeling Consortium and WSDOT.

These tools and information will then be used to describe and predict roadway conditions. For example, data on existing and forecast conditions will be used in pavement temperature models that will predict the potential for roadway icing. This will allow road crews to know when and where to apply anti-icing compounds. Timing is critical because applying the compound too early or too late is ineffective. In addition, being able to target problem areas is important because it is too costly to apply anti-icer to all roads in an area. Former Advanced Technology Branch engineer Guy Coss said, “It is a lot more effective, in terms of cost and safety, to go out and put anti-icer down than it is to go out later and put down de-icer or sand. It’s a matter of being pro-active instead of reactive.”

Information Dissemination

A Web site is being developed to provide WSDOT Maintenance and other decision makers, as well as the public, one-stop access to the resulting current and forecast weather conditions. Available on the rWeather Web site will be weather information; incident, construction, hazard, and mountain pass information from WSDOT’s

Condition Acquisition and Reporting System (CARS); the text displayed on freeway variable message signs; video from freeway surveillance cameras; and possibly an audio format to present highway advisory radio messages. A clickable state map will allow users to find the information at the level of detail they need in the locations they require, with statewide, regional, and local views.

For WSDOT personnel, rWeather will mean access to information about current and forecast road/weather system conditions that may affect operational decisions. Such information is predicted to save costs by reducing worker hours and use of resources. The greater amount of information also will aid marine and aviation interests.

For the public, the result should be increased safety, because the site should allow travelers to make better pre-trip and en route decisions based on more up-to-date and accurate information.

Mass believes the system will reduce weather-related highway fatalities and property damage by giving people the information they need to decide to delay a trip when conditions will be at their worst. Mass noted that in past winters, a number of travelers have been killed or injured in weather-related accidents over snow and ice. "My impression is that a significant number of those could have been prevented if they had had better weather information," he said.

The biggest challenge of this portion of the project will be to organize and offer the large amounts of information in ways that people find easy to manage. For example, whereas travelers might be most interested in knowing simply whether they'll encounter heavy rain along a freeway corridor, WSDOT maintenance engineers might want to know details about temperature, precipitation, and wind speed at specific sites along mountain pass roads. By providing increasingly specialized layers of information, the Web site will be able to accommodate both needs. "There's a tremendous hunger for this type of weather data," Mass said. "I think the problem is finding a way to present key information to people without overloading them.

"We have so much information that we have to find ways to present it without burying people. Getting observational data and doing the forecasts, I know we can do. But finding a way of providing that to a wide range of people in a way that they find useful, that's a tremendous challenge."

Nevertheless, Mass is excited to be involved in a project that has the potential to provide so much benefit. "Probably the nicest thing about it is that this is potentially a project that will have a very major impact. The product will be seen by thousands if not tens of thousands of people a day. I suspect that once we have this Web site up it will be one of the most popular Web sites in the state. I suspect that the detailed weather

information, plus video cameras, roads, pass closure information-all at one stop-will be very, very popular.”

RWeather to Date

According to RWIS Project Manager Bill Brown, the Web site should be completed and running by April 1, 2000, at which time it will replace the current Phase I beta site (found at <www.test.wsdot.wa.gov/rwis>).

5

Eleven of twelve new WSDOT road/weather information stations have been installed and are being connected to regional networks. At this time about ten of those are reporting information. By April 1st, the regional networks should all be united into a statewide network. Data station equipment is also being installed on six Washington State ferries and the Tacoma Narrows Bridge.

For more information about rWeather or WSDOT's road/weather information system, contact Bill Brown at (206) 616-9183, <wwbrown@u.washington.edu>.

Interview with Bob Stowe:

rWeather from a Maintenance Perspective

Bob Stowe is Maintenance Engineer for WSDOT's North Central Region. With administrative offices in Wenatchee, the region has responsibility for state routes in Chelan, Douglas, Grant, Okanogan and Adams counties, including maintenance along the Stevens and Blewitt mountain passes in the Cascade Mountains.

Stowe recently spoke about the potential benefits of the rWeather program for maintenance departments across the state.

Q.: How will departments like yours use the rWeather Web site and data?

Stowe: We can only project how it will be used since it is not completed yet, but what's exciting is how site-specific it will be. It will give weather details for specific locations instead of generic forecasts. As maintenance has evolved in procedures and techniques, we've become more dependent on good, accurate, site-specific weather forecasts. This is the first time we'll have had access to that. In addition is the fact that it will be on-demand and in real time. That means that our people can get the information they want when they need it. So I think that once we start to use it, there will be quite a demand for it.

Q.: The program will eventually include surface temperature forecasts. How important are those?

Stowe: This is critical information for winter maintenance that will be of great benefit. Surface temperature is different than air temperature and determines whether ice will form on the roadway. If the surface temperature forecast says the ground will be above freezing and the weather forecast says that there will be light snow or rain, then we don't need to worry about putting down any chemicals. However, if there's a forecast of rain and the surface temperature forecast could be below freezing, we could prepare to put down chemicals or sand or whatever strategy we'd be likely to use in a particular area. In other words, this is a planning tool that will eliminate a lot of guessing.

6

The fact that the data will be site-specific is important. If you have a maintenance area of 500 lane-miles of highway and the surface temperature forecast indicates that you only need to pretreat half of that area with chemicals instead of all of it, as you might cautiously do if you couldn't predict where the road will freeze, you could benefit from substantial savings.

Also, if the roadway is pretreated with chemicals and the surface temperature rises a little, it is very easy to plow the snow and ice away. If you can predict the time of day when the temperature will rise, you can send the plows out at the right time instead of wasting effort when the ice is still too hard to be removed.

Q.: Who in your area will be most likely to use the information?

The information will be most used by maintenance supervisors and lead technicians.

Q.: Where will it be most useful?

In this state we have to deal with not only seven mountain passes but the Columbia River basin, lower elevation river valleys, and other typographies, each with its own weather-related challenges. The information is helpful for more than just mountain passes. It can be useful anywhere.

Q.: Will it be helpful beyond maintenance activities?

It will be most useful for winter weather maintenance, but there are potential applications in other operations. For example, you can't stripe in the rain. Our striping crew is located in Wenatchee but might have to stripe 100 miles away. If they could look and see that a large rainstorm was going to occur in that area, they might save time and money by going to another location to stripe. There are also some paving operations that need the surface temperature to reach a certain level before paving can proceed. The Web data would allow paving at the right time.

Snow Removal Goes High Tech

An important reason for improving road-weather information systems is to give highway agencies better information about local winter road conditions. Clearing busy highways during the winter months can be treacherous, so information about localized temperatures and weather can be particularly helpful for snow removal.

In related work, two studies in California and the midwest are researching better snow removal techniques and equipment.

7

AHMCT Advanced Snowplow Project

The Advanced Highway Maintenance and Construction Technology Center at the University of California, Davis, is helping to improve snow removal operations by developing systems that will locate the roadway and obstacles under the snow. The Advanced Snowplow Project demonstrated a driver information system during the winter of 1998/1999. Tested were displays in the snowplow that show where the plow is relative to roadway and that detect obstacles in the plow's path.

For roadway guidance, specially designed magnets were installed in a test section on Highway 80's Donner Summit in California. The system uses magnetometers and vehicle positioning technologies for vehicle guidance. Additional test sections will be installed in California, Arizona, and other states.

For obstacle detection, radar finds obstacles in the path of the snowplow, as well as the wingplow, which projects into the adjacent lane. These radar units were designed to provide both the sensitivity necessary for accurate obstacle detection and the ruggedness necessary for durable reliability.

Both systems were designed to operate in the harsh conditions typical of the snowplow environment.

Future work may include automation to guide the snow removal vehicle along the snow-covered highway and to avoid collisions by stopping, slowing, or moving the plow around a snow-hidden obstacle.

Technical development for the Advanced Snowplow Project involves a partnership between the AHMCT Research Center and UC Berkeley's Partners for Advanced Transit and Highways (PATH) Center. A third partner, the Western Transportation Institute of Montana State University, will evaluate operational improvements.

For more information, see

<http://venus.engr.ucdavis.edu/ahmct_roadways_snowplow.html>.

CTRE Concept Highway Maintenance Vehicle

The Center for Transportation Research and Education at Iowa State University is taking a different approach. The goal of the Concept Highway Maintenance Vehicle research project, supported by a consortium of the Iowa, Michigan, and Minnesota departments of transportation, is to evaluate the feasibility of using advanced technologies from other industries to improve the efficiency and safety of winter highway maintenance operations. This project is a testbed for a variety of technologies.

8

Input for the vehicles' design came from focus groups whose participants included DOT equipment operators, mechanics, and maintenance managers and supervisors, as well as representatives from other organizations with an interest in the new vehicle, including law enforcement and emergency response personnel. In addition, private partners in the research effort include Rockwell International, Navistar, Norsemeter, and Global Sensor Systems.

The prototype vehicle is a standard tandem axle truck with a 22,680 kg (50,000-lb) gross vehicle weight. Iowa and Minnesota's trucks have dump boxes, while the Michigan truck has a chassis-mounted material spreader and brine tank. All three trucks have front, wing, and underbody plows.

The trucks' features include a global positioning system (GPS) receiver that determines the location of the vehicle every 5 seconds. These data are recorded by a new on-board system, called Plowmaster, that was developed by Rockwell especially for the prototype vehicle. The trucks are also equipped with newly designed liquid and granular spreading equipment that can dispense dry, prewetted, or liquid materials for deicing or anticing operations. Other features include a hydrous-ethanol injection system that automatically injects ethanol fuel whenever an engine power boost is needed; fiber-optic lighting that provides more visibility during storms and whiteout conditions; and a custom-designed device that measures and records the friction of the road surface. This device signals the driver and the on-board computer when more chemicals are needed to prevent the pavement from becoming slippery.

Each vehicle also has a Road Watch Warning System, which monitors the air and pavement surface temperature, and a Search-Eye Sensor System, which detects vehicles or obstructions behind the truck and automatically applies the brakes if necessary when the truck is put into reverse.

In addition to recording GPS data, the Plowmaster collects data from the trucks' pavement surface and air temperature sensors, friction meter, and material applicator, as well as selected engine information. The states hope to be able to transmit these data directly to computers at maintenance garages and traffic operations centers in order to

better coordinate operations and improve weather advisory information.

The second generation of these vehicles will include a device that measures salt brine concentration. This unit is mounted in back of the wheels to report what the current diluted chemical rate is on the road surface. This lets operators adjust chemicals as needed.

Although many of the trucks' features had not been used together before, the technologies have proved to be compatible. Other states may not need all of the technologies tested on the prototype trucks, but they can use information from the project to adopt any of the technologies that might meet their own requirements.

For more information, see <<http://www.ctre.iastate.edu/Research/conceptv/mou.pdf>>.

To discuss any of the information in this newsletter contact Bill Brown by email: <wwwbrown@u.washington.edu> or by phone: (206)616-9183.

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